Overview

Charcoal rot of soybean is caused by a soilborne fungus *Macrophomina phaseolina*. This disease had been considered primarily a southern soybean problem, but recently has emerged as a threat in the North Central region of the U.S. and Ontario, Canada, where weather trends favorable for disease development — such as warmer summer and winter temperatures and reduced rainfall — have likely contributed to its presence.

The fungus causes a general root rot in soybean, infecting the roots and lower stems. The name *charcoal rot* is descriptive of the small black fungal structures, called microsclerotia, on the lower stem of infected plants. Yield loss from charcoal rot is highly variable, but farmers can reduce crop injury by implementing best management practices based on a better understanding of this disease.

Plants of any age can be affected by charcoal rot. The initial infection occurs in the spring when soil moisture is high. However, symptoms remain latent unless stressful environmental conditions, especially hot, dry weather, occur during the mid- to late season as the crop begins to flower and form pods.

Scouting

See Charcoal Rot (CPN 1004) for a complete discussion and diagnostic photos of soybean diseases with similar symptoms.

In the North Central region, visible symptoms, when they occur, generally do not appear until the later stages of pod fill. The characteristic sign of charcoal rot is the microsclerotia in root...
and stem tissue, and these may not be visible until maturity or plant death.

Microsclerotia may be visible on the lower portion of the plant, often just under the outermost layer of stem tissue. To the naked eye, it will look as if the root or stem has been “peppered” with black spots (upper photo). Upon closer inspection with a hand lens, individual microsclerotia can be seen within the plant tissue (lower photo). See Scouting Soybean Stem Diseases, Crop Protection Network.

**Symptoms**

Symptoms of charcoal rot begin typically in the driest areas of the field such as sandy or compacted areas, or the tops of terraces. Infected plants wilt in the midday heat, recovering at night until the permanent wilt point is reached.

Plants infected by the charcoal rot pathogen may have premature yellowing of the top leaves and premature leaf drop. This is easy to mistake for normal maturity. Look for unfilled upper pods and general low plant vigor. In some cases, the upper one-third of the plant may have only flat pods without seed.

Beginning at flowering, a light gray discoloration develops on the epidermal and sub-epidermal tissues of both tap and secondary roots and lower stems. Scrape the outer tissues and use a hand lens to look for the presence of black microsclerotia – a diagnostic symptom of charcoal rot.

**Increased susceptibility to root rot**

In some cases, charcoal rot symptoms may appear in lower wetter areas of the field. In these instances, the soybeans usually will have symptoms of root rot from a previous infection of *Pythium, Phytophthora* or *Rhizoctonia*.

The damaged root system decreases the ability of the roots to move water from the soil to the plant, putting the plant under moisture stress. In these situations, the charcoal rot fungus can be considered a secondary invader.

**Risk Assessment**

Stress caused by excessive plant populations, soil compaction, improperly applied herbicides, nematodes, or other diseases avors the charcoal rot pathogen and increases the risk of infection.

Unlike most soil fungi, which decline in activity when soils become too warm, the charcoal rot fungus is most active when soil temperatures are as high as 80-95°F (27-35°C). Fungal
growth and survival is favored by dry soils, conditions that weaken and stress the soybean crop, particularly during the reproductive growth stages.

Management

Use varieties with the highest level of resistance available in a maturity group appropriate for your area.
Plant the fullest-season varieties that are practical. Plants are most susceptible to charcoal rot at the beginning at flowering. The longer-season varieties tend to flower later and are in a vegetative growth stage during the early part of the hottest, driest portion of the growing season.

Use no-till systems to increase soil microbial activity and conserve soil moisture, which can reduce charcoal rot.
Soybeans direct-seeded in no-till systems typically have lower levels of charcoal rot compared to soybeans under conventional tillage.

Rotate to non-host crops for 1 to 2 years in fields with a history of charcoal rot.
Rotation to non-host crops such as wheat and other small grains for 1 or 2 years should be considered part of a charcoal rot management plan in problematic fields. Also, although corn, sunflowers, and other crops are hosts, research has shown that there are strains of the fungus that have host preferences. For instance, some strains prefer soybeans while others prefer corn or sunflowers. Therefore, rotation with any other crop can be beneficial and the longer the rotation, the better.

Avoid excessive seeding rates to reduce crop stress and minimize loss to charcoal rot.

Consider supplemental irrigation to slow colonization of the plant by the charcoal rot pathogen and reduce symptom severity during drought conditions.

Fungicides do not provide protection
No fungicide seed treatments have been identified that offer consistent control of charcoal rot.

Resources

Charcoal Rot
Crop Protection Network, 2015
Advancing Our Understanding of Charcoal Rot in Soybeans
Journal of Integrated Pest Management, 2017
https://academic.oup.com/jipm/article/8/1/8/3064076

Charcoal Rot in the North Central Region: a series of videos on charcoal rot research, field identification, and management of this emerging disease.
Soybean Research Information Initiative
https://www.youtube.com/channel/UC1EL0JQW26cP1WsCdW8mpXQ

Scouting for Soybean Stem Diseases
Crop Protection Network CPN 1002, 2015

Seasonal Progress of Charcoal Rot and Its Impact on Soybean Productivity
Plant Disease, 2011

Soybean Stem Zone Lines - Zone lines are a symptom of diseases caused by Diaporthe species of fungi
Crop Protection Network CPN 1015, 2016

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